Coupled Magnetosphere-Ionosphere-Thermosphere Simulation of the System Response to a Sudden Reversal in the Interplanetary Magnetic Field B_y Component

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STUDY CONCLUSIONS

The finite rate of magnetic reconnection can delay changes in the ionospheric ExB drift.

- The ionosphere showed that there was circulation on closed field lines.
- We discovered a buildup in the form of a flux rope on the dusk side of the magnetopause.
- The ionospheric pattern couldn't fully reverse until the flux rope cleared.

MOTIVATION

Earth's ionosphere is part of the global system in which man-made satellites move and operate. The ionosphere and magnetosphere are intimately connected, so what happens in one affects both the other and the entire system.

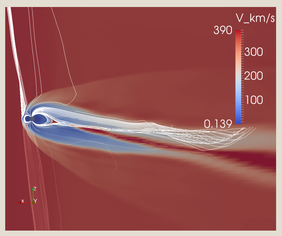

Figure 1. The earth's magnetic field interacting with the IMF.

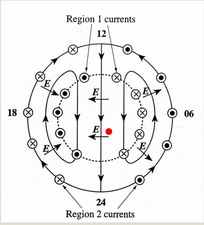

Figure 2. ExB drifts under B_z conditions. Image credit: Canadian Space Science Data Portal.

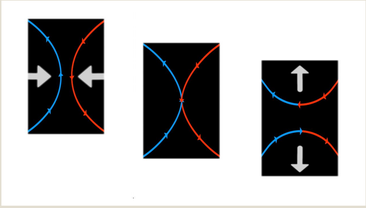

Figure 3. Magnetic field lines enter the reconnection region, reconnection occurs, and the two new lines shoot off in opposite directions. Image credit: NASA.

THE EVENT UNDER CONSIDERATION

A delay in ionosphere pattern reversal

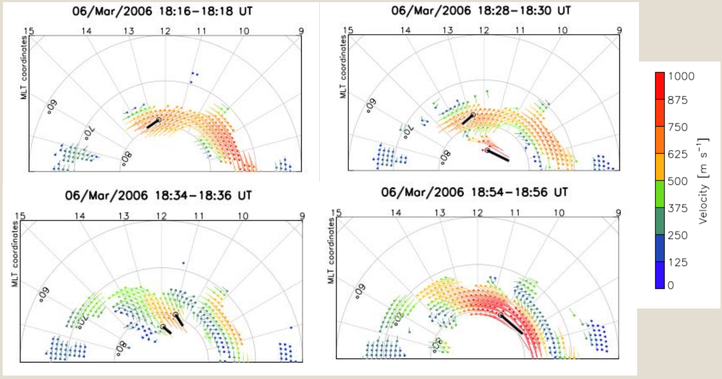

Figure 4. ExB drifts over the North Pole as seen by SuperDARN. Image credit: Eriksson et al., 2017.

METHODS

- Ran CMIT simulation of the event
- Plotted ionosphere data and polar open-closed boundary
- Used stream tracers to calculate magnetic field lines and to identify the separator

IONOSPHERE RESULTS: DISSIPATION

Qualitative reproduction of observations

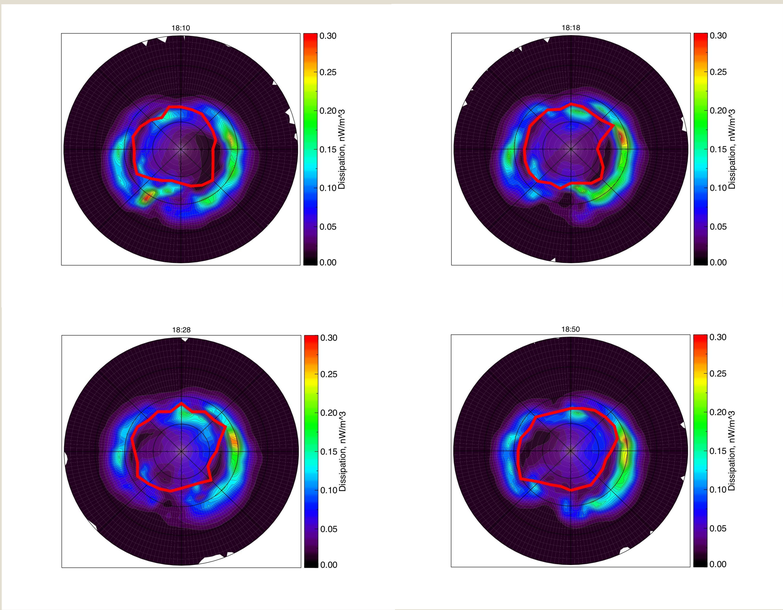

Figure 5. Plots of J · E (dissipation) over the North Pole, along with the polar open-closed boundary. Series shows before, during, and after the pattern reverse.

IONOSPHERE RESULTS: POTENTIAL

Circulation on closed field lines

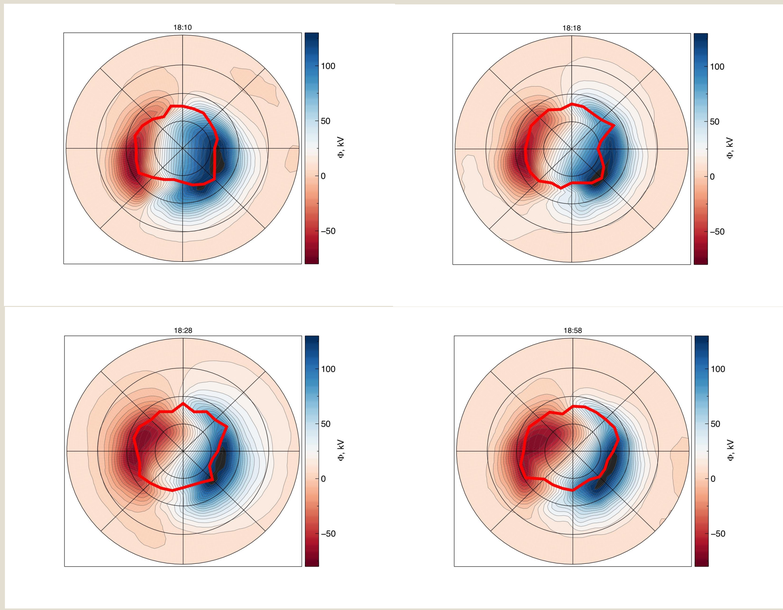

Figure 6. Plots of the polar cross-cap electric potential and the open-closed boundary.

MAGNETOSPHERE RESULTS

A flux pileup with different kinds of magnetic reconnection

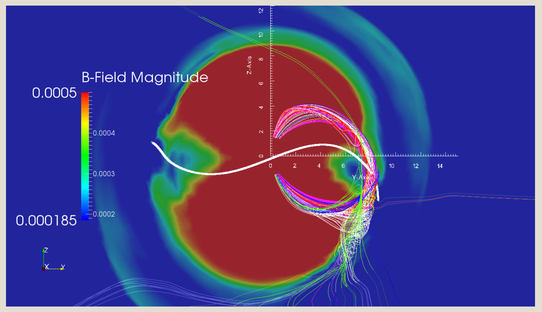

Figure 7. Plot of the magnetosphere (GSM coordinates), first stages of the reversal.

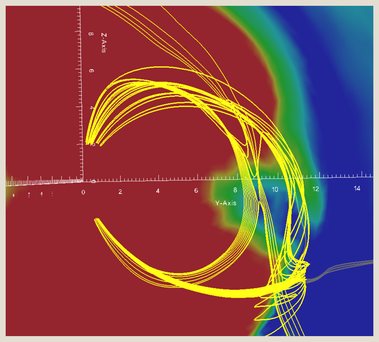

Figure 8. Part of the flux rope, showing the different kinds of reconnection occurring.

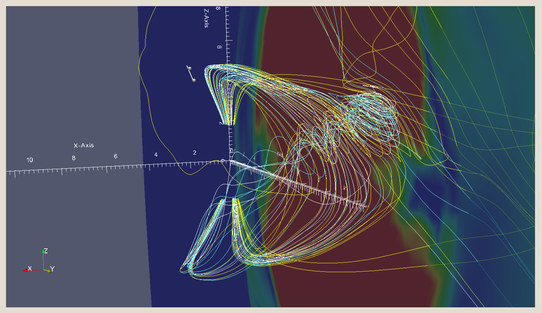

Figure 9. About 20 minutes after the flip, the flux rope has moved up into the Northern Hemisphere and back into the magnetotail.

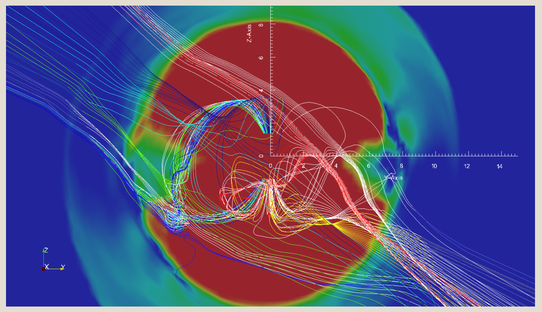

Figure 9. After the pattern reverses, a matching flux rope shows up on the opposite side of the dayside.

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REU Site: Solar and Space Physics with the Boulder Solar Alliance